IV. *Observations on the Structure of the different Cavities, which constitute the Stomach of the Whale, compared with those of ruminating Animals, with a View to ascertain the Situation of the digestive Organ.* *By* Everard Home, *Esq. F. R. S.*

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THE following observations are in some measure a continuation of those upon the stomachs of ruminating animals contained in a former Paper. They are intended to show that the stomach of the whale forms a link in the gradation towards the stomachs of truly carnivorous animals.

This subject was brought under my consideration by the following circumstances. While at Worthing, on the Sussex coast, in the month of August last, a Delphinus Delphis of LINNÆUS, or small bottle-nose whale of Mr. HUNTER, was brought on shore by the fishermen alive. I immediately purchased it, with a view of enriching the HUNTERIAN collection with the skeleton, and other parts of its structure.

The stomach was the particular object of my own attention; for, having been so lately employed in considering the stomachs of ruminating animals, I was pleased with an opportunity of examining in a recent state the stomach of one of the whale tribe, to which the porpoise belongs, with a view to ascertain more accurately than had been hitherto done, the real resemblance between its structure, and that of the stomachs of ruminating animals.

The structure of the stomach of one species of whale was not new to me, having twenty years ago assisted Mr. HUNTER in dissecting the piked whale, but at that time I only viewed the different parts of its structure with the eye of a common observer, while now my mind was particularly directed to the peculiarities of the stomach. In this examination I discovered a resemblance between the second, third, and fourth cavities in the whale, and the two portions of the fourth cavity in the bullock and camel, which appears to throw some light upon the uses of those parts, as well as upon digestion in general.

As in the former Paper a particular description was given of the stomach of the bullock and camel, as examples of ruminants with and without horns, it will be proper here to describe the stomach of the bottle-nose porpoise, as an example of the whale tribe.

In the bottle-nose porpoise the œsophagus is very wide, has a number of longitudinal folds, and is lined with a strong white cuticle, which is continued over the internal surface of the first stomach.

The first stomach lies in the direction of the œsophagus, which is continued into it, there being no contraction to mark its origin. It is of an oval form, and bears a strong resemblance in shape to a Florence flask. The cavity is 15 inches in length, and 9 in diameter. The internal surface has a very corrugated appearance, and its cuticular covering is thick and strong. The coats of the cavity are firm, and its bottom is surrounded by a strong muscular covering.

The orifice, which leads to the second stomach, is at right angles to the cavity, and is situated a little way below the

termination of the œsophagus. It is surrounded by several semicircular doublings of the internal membrane: the broadest of these is on the lower part, these are thick, and appear to be glandular.

There is a canal between the first and second cavities 3 inches long, which opens into the second by a projecting orifice, and the cuticular covering of the first stomach terminates immediately beyond this orifice, which is $2\frac{1}{2}$ inches in diameter.

This second stomach is nearly spherical, about 7 inches in diameter. Its internal surface has a honeycombed appearance, formed by soft ridges of a glandular structure, leaving interstices of some depth between them. This structure gives the coats a considerable degree of thickness.

The opening into the third stomach is almost close to that which enters the second, and is only $\frac{5}{8}$ of an inch in diameter.

The third cavity is nearly spherical, and is 2 inches in diameter. Its internal surface is smooth, and there are every where small orifices of ducts of glands opening into its cavity. The aperture, which communicates between this and the fourth stomach is $\frac{3}{8}$ of an inch in diameter.

The fourth cavity is nearly cylindrical like an intestine, but rather widest at its furthest extremity. It is $14\frac{1}{2}$ inches long; its greatest diameter is 3 inches. The internal membrane is smooth, and for 3 inches towards its origin, and 4 inches towards its termination has numerous orifices through which secretions are poured into the cavity. The pylorus, which is the boundary of this stomach, is a round orifice $\frac{2}{8}$ of an inch in diameter.

Immediately beyond the pylorus there is a dilatation of the gut, which both CUVIER and HUNTER call a cavity belonging to the stomach. It must however be considered as duodenum, since the common duct of the liver and pancreas opens into it; the longitudinal *valvulæ conniventes* have their origin in it; and there is no transverse constriction any where beyond it, to mark the beginning of an intestine. Such an enlargement of the duodenum is very common in other animals, and has been described in the account of the camel. The coats of this portion of the duodenum are thicker than those of the fourth stomach. The annexed drawings (Plate III.) will give a better idea of these different parts than can be conveyed by any verbal description.

The number of cavities constituting the stomach are not the same in all animals of the whale tribe. In the common porpoise, grampus, and piked whale, the number is the same as in the bottle-nose porpoise; but in the bottle-nose whale of Dale there are two more cavities. This variation is however by no means material, since the general structure of the stomach is the same.

In all of the whale tribe there is one cavity lined with a cuticle, as in the bullock and camel.

In all of them there is a second cavity made up of a very glandular structure. In the porpoise, grampus, and large bottle-nose whale this structure resembles that which is above described. In the piked whale the rugæ are longitudinal and deep, but in some places united by cross bands; and as the piked whale has whalebone teeth, the great whalebone whale will probably, from the analogy of its teeth, resemble it in the structure of its stomach.

The third cavity in all of them is very small, and bears a strong resemblance to the third cavity in the camel's stomach; its use, therefore, is probably the same.

The fourth stomach in all of them has a smooth internal surface, with the orifices of glands opening into its cavity. In the bottle-nose whale of Dale the two additional cavities have the same internal structure, and therefore must have the same general use, with a greater extension of surface, and the subdivisions will make the food pass more slowly into the intestine.

The first stomach of the whale is not only a reservoir, but the food undergoes a considerable change in it. The flesh is entirely separated from the bones in this cavity, which proves that the secretion from the glandular part has a solvent power. This was found to be the case in the bottle-nose porpoise and large bottle-nose whale. In both of them several handfuls of bones were found in the first stomach, without the smallest remains of the fish, to which they belonged. The soft parts only can be conveyed into the second and third stomachs, the orifices being too small to admit the bones to pass.

The bones must therefore be reduced to a jelly in the first stomach, and although the process, by which this is effected, being slower than that, which separates the flesh, is the reason of their being found in such quantity in the cavity, the means by which it is performed are probably the same.

The second cavity was supposed by Mr. HUNTER to be the true digesting stomach, in which the food becomes chyle, and the use of the third and fourth he looked upon as not exactly ascertained.*

* *Vide* Observations on the Structure and Œconomy of Whales. By JOHN HUNTER. Phil. Trans. Vol. LXXVII. page 411.

Upon what ground Mr. HUNTER was led to draw this conclusion cannot now be ascertained; and, such is my respect for his opinion, that nothing but the following observations, supported by facts, could lead me to form a different one. In considering this subject, it struck me that the second stomach, could not be that, in which chyle is formed, since that process having been completed, any other cavities would be superfluous. The last cavity in all stomachs is that, in which the process must be brought to perfection: and therefore the most essential change, which the food undergoes, or that, by which it is formed into chyle should be performed in that cavity. Surveying the different cavities, in the whale's and ruminating stomachs with this impression on my mind, and comparing them with the single stomachs of carnivorous animals, it appeared that the first point, which required to be ascertained was, which of the cavities in these more complex stomachs bears the greatest resemblance to the simple one. The fourth of the whale is certainly more like the human stomach than the second or third. I therefore concluded that the fourth, both from analogy and situation, is the stomach in which the process is completed: and that in this animal, from the peculiarities of its œconomy, and the nature of the food, not only a cuticular stomach is necessary, but also two glandular ones, in which it undergoes changes preparatory to its being converted into chyle.

Having satisfied myself upon this subject, and having compared the stomachs of the whale, with the fourth of the camel, the contraction or partial division of the camel's, made it apparent that the lower portion only of that cavity, which resembles in shape, and internal appearance the human

stomach, is the cavity in which chyle is formed, and the upper or plicated portion is only to prepare the food, and is therefore analogous to the second in the whale.

As the same appearances are met with in the fourth stomach of the bullock, as well as in the camel, although there is no permanent contraction, or division between them, the upper or plicated portion must be considered as a preparatory organ, and the lower portion as that, in which the formation of chyle is compleated. This receives further confirmation from a more attentive examination of the parts, immediately after death, by which it was found that before the stomach has been disturbed there is an evident muscular contraction between the plicated and lower portion. This appearance was met with in every instance that was examined, and these were not fewer than nine or ten. Added to this the lower portion, on a more minute inspection, has an appearance somewhat similar to the inner membrane of the human stomach: and the surface of the plicæ is in many respects different.

From the facts and observations which have been stated, it appears that in many animals of the class Mammalia, the food undergoes different changes preparatory to its being converted into chyle, and this last process is effected by a somewhat similar secretion, since the part of the stomach which produces it, has in all of them an evident similarity of structure.

The above facts appear to throw some light on the digestion of the different kinds of food, and open a wide field of enquiry into one of the most interesting parts of the animal œconomy, which has been hitherto too much neglected. In the present very limited state of our knowledge there are

many circumstances which cannot be accounted for: these however, will be explained when a further progress has been made in this investigation.

It is obvious, that as the stomachs of carnivorous animals are the most simple, animal substances, on which they feed, require a shorter process to convert them into chyle than vegetables; but why the whale tribe, which live on fish, should have a more complex stomach, it is not easy to explain: since fish are very readily converted into chyle, in the stomachs of animals of their own class, as well as in the human stomach, and there is therefore reason to believe that they require as little preparation for that process, if not less than animal substances.

The fish bones swallowed by the whale tribe being retained in the cuticular bag, till they are reduced to jelly, explains the circumstance of cows, and other ruminating animals being able occasionally to live on fish, (a fact, of which there is no doubt, both in the Orkneys and in Iceland,) since, if the bones are dissolved in the paunch, the other stomachs, are in no danger of being injured from the animal living on this kind of food.

Whether these cavities, which I have called preparatory stomachs, are solely for purposes connected with digestion, or are also in any way connected with the formation of secretions peculiar to those animals, cannot be ascertained in the present state of our knowledge of digestion.

The oil of the physeter, which crystallizes into spermaceti, shews some affinity in this respect to the secretion of fat, that becomes suet, which is only met with in ruminating animals: but on the other hand, the oil of the rest of the

whale tribe does not form this substance, more than the fat of the horse produces tallow. These facts may be afterwards explained by an examination of the digestive organs of the physeter, when an anatomist shall have an opportunity of examining them.

These are enquiries which do not belong to the present Paper, as it is only intended to add some facts to those already laid before the Society, and in a future communication I hope still further to increase their number.

EXPLANATION OF THE PLATES.

(PLATE III.)

This plate represents the first cavity of the stomach of the bottle-nose porpoise laid open to shew its internal structure.

a a. The œsophagus lined with cuticle.

b b. The first cavity of the stomach, also lined with cuticle.

c c. The glandular structure forming folds round the orifice leading to the second cavity, also lined with cuticle.

(PLATE IV.)

This plate represents the internal surface of the second, third, and fourth cavities of the stomach.

a a. The outside of the first cavity to shew its external form.

b b. The inner surface of the second cavity, made up of a honey-combed structure, composed of soft membraneous folds, which have no cuticular covering.

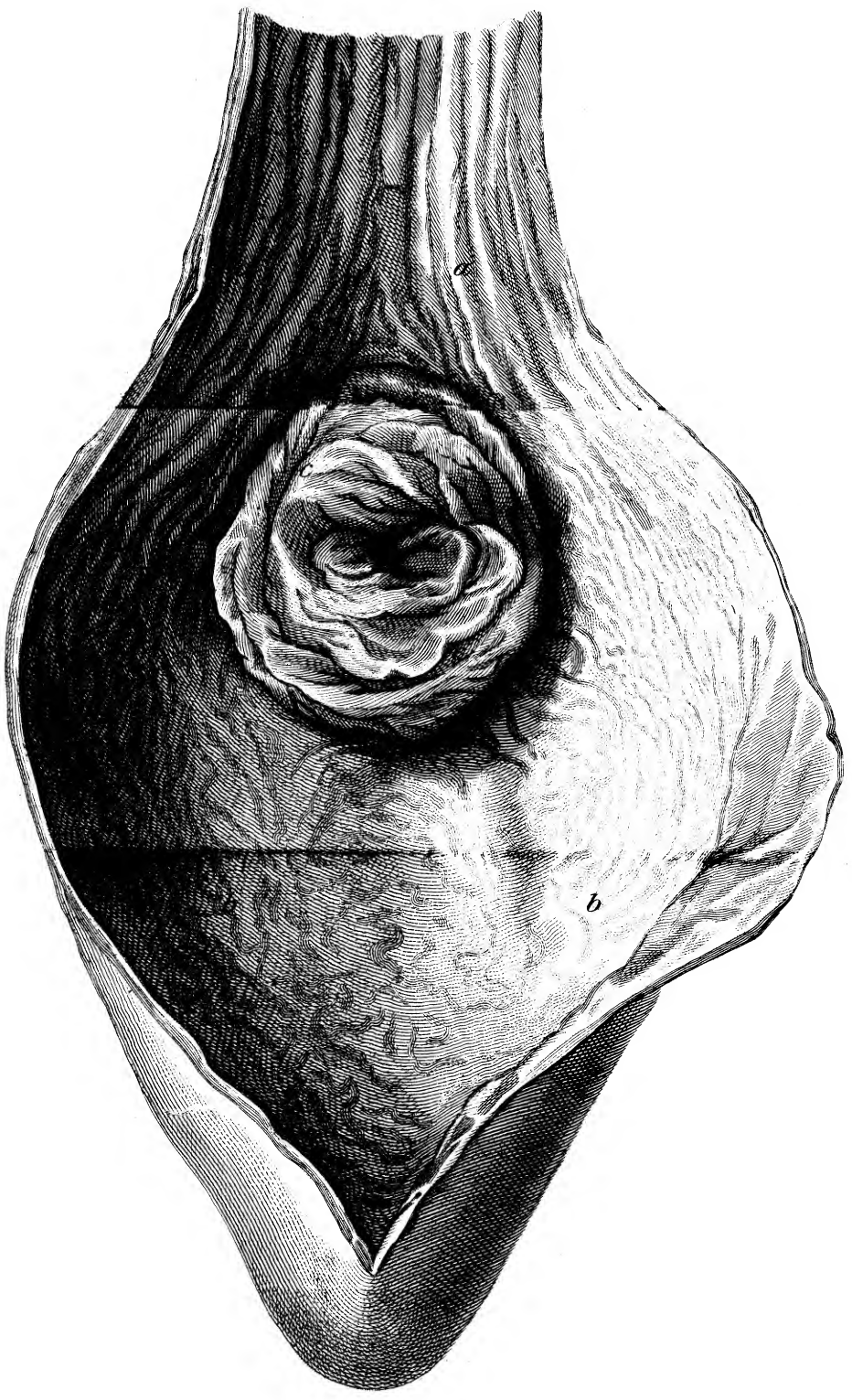
c c. The third cavity.

d d. The fourth cavity.

e e. The orifices of excretory ducts of glands.

f f. The enlargement of the substance immediately beyond the pylorus, into which the common duct from the liver and pancreas opens.

g. The opening of the common duct.



SCALE_Six Inches to a Foot.

Wm. Clift del.

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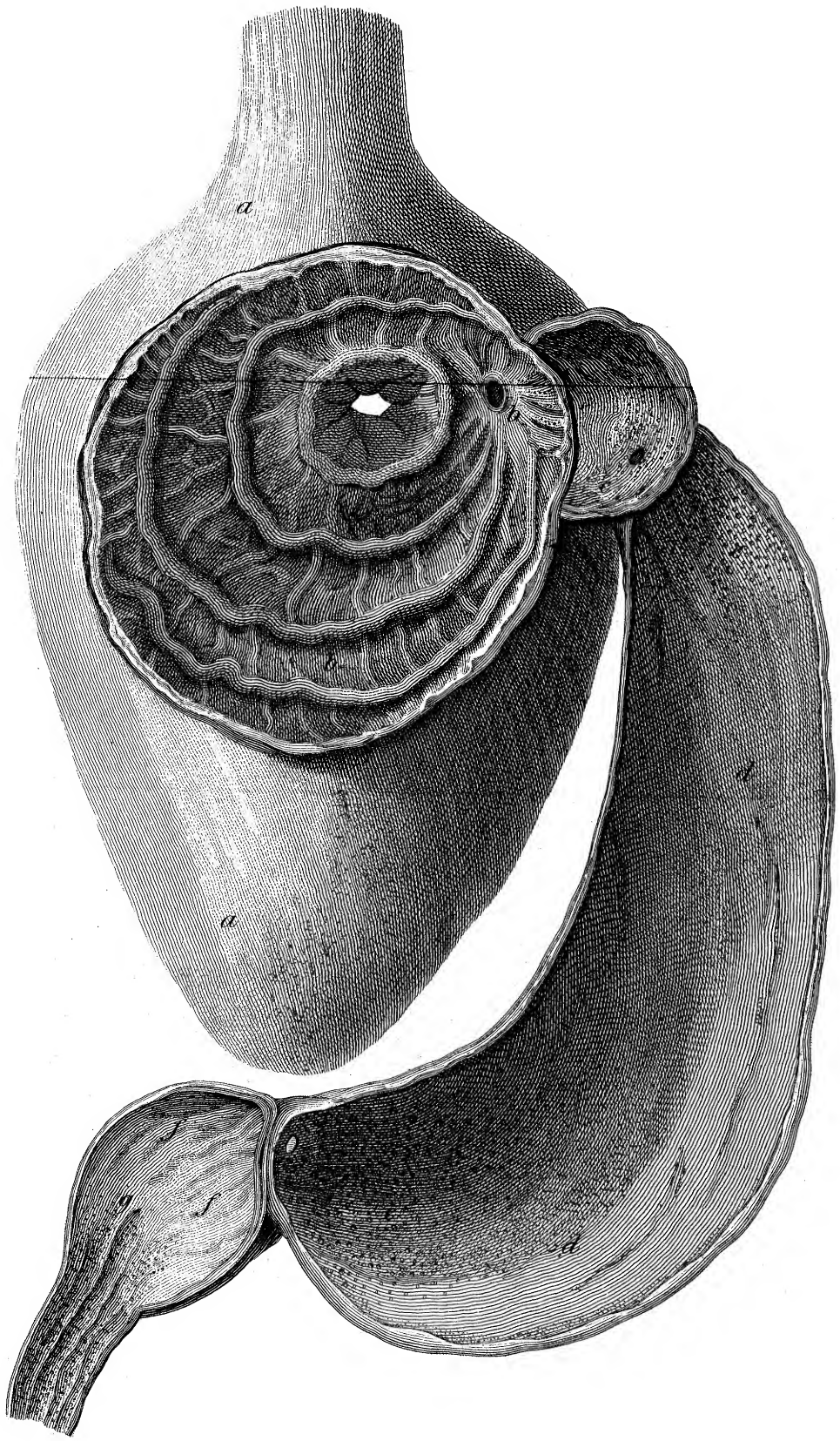

*SCALE*_ *Five Inches to a Foot.*

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